hydration of the outer surface extends through the thickness of the membrane and reaches the inner surface, it there receives a check. . . . The contact of the saline fluid is thus attended by a continuous catalysis of the gelatinous hydrate, by which it is resolved into a lower gelatinous hydrate and free water. Now this question of hydration is perhaps the most remarkable instance of the persistent continuity of Mr. Graham's work, as Dr. Odling has pointed out,[1]—"it is noteworthy that for him (Mr. Graham) osmosis became a mechanical effect of the hydration of the septum; that the interest attaching to liquid transpiration was the alteration in rate of passage consequent on an altered hydration of the liquid, and that the dialytic difference between crystalloids and colloids depended on the dehydration of the dialytic membrane of the former class of bodies only."

I must now direct your attention to a section of Mr. Graham's work, which, although it was the last, was a reversion to some of his very earliest experiments. In 1829, under the title, "Notice of the Singular Inflation of a Bladder," he described the following experiment:—A bladder two-thirds filled with carbonic acid was introduced into a bell jar filled with carbonic acid gas; after the lapse of some hours the bladder was found to contain 35 per cent. of carbonic acid, and to have become distended. Mr. Graham observes:—"M. Dutrochet will probably view in these experiments the discovery of endosmose acting upon aëriform matter as he observed it to act on bodies in a liquid state. Unaware of the speculations of that philosopher at the time the experiment was made, I fabricated the following theory to account for them:—The jar of carbonic acid standing over water, the bladder was moist, and we know it to be porous. Between the air in the bladder and the carbonic acid without there existed capillary canals through the substance of the bladder, filled with water. The surface of the water at the outer extremities of these canals being exposed to carbonic acid, a gas soluble in water would necessarily absorb it. But the gas in solution . . . permeated the canal, and passed into the bladder and expanded it."[2]

You will remember that in the concluding experiments on the diffusion of gases Mr. Graham employed a tube, closed with a graphite disc (Fig. 2), in which a Torricellian vacuum could be produced. In his experiments on the penetration of different gases through membranes the same apparatus was employed, only the disc of graphite was replaced by a film of india-rubber. He found that gases penetrated to the vacuous space at the rates given in the last column of the table (p. 512). You will observe that the gas which penetrates most rapidly is carbonic acid, and you will also see that the rates of passage are in no way connected either with those of diffusion or transpiration.

A comparison of the relative rates of passage of oxygen and nitrogen led to a most remarkable experiment. Oxygen penetrates 2½ times as fast as nitrogen, therefore by dialysing air Mr. Graham actually increased the quantity of oxygen from 20·8 to 41 per cent., just as he had effected, by the aid of a tobacco-pipe, a partial separation of oxygen from air by the slightly greater diffusion velocity of nitrogen. The Torricellian vacuum was ill adapted for the experiments, and Mr. Graham gladly availed himself of the mercurial exhauster devised by Dr. Hermann Sprengel, and he considered that without the aid of this instrument it would have been impossible to conduct certain portions of the research. He was thus able to use larger septa of india-rubber, bags of waterproof silk being found to be most convenient (Fig. 8). The vacuum was not even absolutely necessary, for the penetration of the nitrogen and oxygen of air through rubber into a space containing carbonic acid could be readily effected, the gas being absorbed by potash at a certain stage of the operations.

Mr. Graham considered this penetration to be due to an actual dissolution of the gas in the substance of the india-rubber, for, as he observes, "gases undergo liquefaction when absorbed by liquids and by soft colloids like india-rubber," words I think of interest, when we remember that the sentence only marks a slight extension of the view he expressed in his first paper in 1829.

These discoveries led Mr. Graham to inquire whether it was probable that the discovery of MM. Troost and Deville of the penetration of red-hot platinum and iron tubes by hydrogen, could be due to an actual absorption and liquefaction of the gas in the pores of the metal, and by submitting the question to the test of experiment it was proved that such an absorption did take place.

[1] Lecture on "Prof. Graham's Scientific Work," Royal Institution, January, 1870.

[2] Quart. Journ. Sci., 1829, p. 88.

For instance, palladium was found to act as platinum only in a more marked manner. A tube of palladium when attached to the mercurial exhauster did not allow hydrogen to pass in the cold, but when heated to redness in an atmosphere of hydrogen the gas passed through the walls of the tube at the rate of 4,000 cubic centimetres per square metre in an hour (Fig. 9). This led to the remarkable discovery of the absorption or occlusion of gases by metals. It was found that nearly all metals appear to select one or more gases. Silver, for instance, absorbs many times its volume of oxygen, and under certain circumstances gives it out again on cooling. Iron is specially characterised by its absorption of carbonic oxide, but it also retains hydrogen, and this fact led Mr. Graham to extract from meteoric iron, the gas that probably affected its reduction to the metallic state, and which certainly exists in the atmosphere of certain stars.

The most remarkable results were obtained with palladium. I called your attention at the beginning of the lecture to the index which you will observe has moved six inches.

I will now describe the apparatus; it consists of a tall jar filled with acidulated water; at the bottom of the jar two wires are fixed, and these wires are parallel throughout the entire length of the jar. Each is attached to the short arm of a lever, the longer arms of which are about five feet long. One wire is of palladium, the other of platinum, and they form the electrodes of a small battery capable of decomposing the water. The palladium now forms the negative electrode, and is freely absorbing hydrogen, the excess of which is escaping from its surface. The absorption of hydrogen has been attended by a considerable expansion, as is shown by the fall of the index. The index attached to the platinum wire has of course remained stationary.

This expansion enabled Mr. Graham to calculate the density of the gas in its condensed form, and for reasons which I cannot give you now he was led to believe that hydrogen gas is the vapour of a white magnetic metal of specific gravity 0·7.

Now by taking palladium which has been charged in the manner you have seen, and heating it *in vacuo*, I can actually extract and show you the hydrogen it contained. This little medal of palladium contains an amount of gas condensed into it which would be equivalent to a column of gas more than a yard high, and of the diameter of the medal.

The story of Mr. Graham's work has been much better told by Odling, Williamson, Hofmann, and Angus Smith, but what does it teach us from a point of view of a collection of scientific apparatus? Surely that, although in certain researches or for accurate observation and measurement, delicate and complicated instruments may be necessary, the simplest appliances in the hands of a man of genius may give the most important results. Thus we have seen that with a glass tube and plug of plaster of Paris, Mr. Graham discovered and verified the law of diffusion of gases. With a tobacco-pipe he proved indisputably that air is a mechanical mixture of its constituent gases. With a tambourine and a basin of water he divided bodies into crystalloids and colloids; and obtained rock crystal and red oxide of iron soluble in water. With a child's indiarubber balloon filled with carbonic acid he separated oxygen from atmospheric air, and established points, the importance of which, from a physiological point of view, it is impossible to overrate. And finally, by the expansion of a palladium wire, he did much to prove that hydrogen is a white metal.

GERMAN EXPEDITION TO SIBERIA[1]

"WE stayed in Lepsa until May 17. We obtained some varieties of lizards, one kind of frog, and a toad, a kind of fish like the barbel, and all sorts of varieties of cobitis, but no salmon. We obtained only a few beetles and butterflies, but we had a rich collection of the flora. On May 13 and 14 we made a short excursion into the mountains and found several new kinds of birds differing decidedly from the European kinds, *e.g.*, the *Cinclus leucogaster*, with the white belly, the *Motacilla personata*, the *Pica leucoptera*, a fine Carduelis, and a splendid specimen of the red-finch.

"On May 15 we made a long excursion to the Dschasyl Kul (green lake), 6,000 feet above the level of the sea. The abundance of trees and bushes has a most agreeable effect, and above all is the mild red and pink of the wild apple-tree (*Pirus Sieverianus*) pleasing to the eye. The lake, lying amongst high

[1] The second letter dates from Saissan, in Russian Turkestan, May 27, 1876. Continued from p. 359.

mountains covered with snow, is surrounded by beautiful fir and other trees. We threw out our dredge but without success, neither did we see any large game, *e.g.*, steinbok or maral. The maral is a kind of stag entirely different from ours, with immense antlers, which are very rarely to be obtained, as they are considered a delicacy by the Chinese, who eat these antlers before they are quite developed, *i.e.*, in their soft, hairy state. For a pair of antlers scarcely eight inches high, the Kirghiz asked twenty rubles.

"On May 17 we left Lepsa and turned again towards the lake Ala Kul, this time to its east side. While crossing the height that closes the valley of Lepsa on the north, we mounted a peak whence we had a most beautiful view, especially of the high distant Ala Tau with its cones covered with eternal snow. On the 18th we descended into the steppe after having once more camped in yurts upon the mountains; it began to be very warm. The road leads through the steppe; it is for the greater part covered with reeds, and shows everywhere traces of boars, so we guessed to be near the lake, which we reached towards night. Numerous cranes, ducks, pelicans, gulls, and other water-fowl and moor-fowl animated the shore.

"On the 19th our road led through a grass-steppe covered with hemlock and rhubarb, and interspersed with bare alkali-soil; near the rivers were numerous 'auls' of the Kirghiz, with herds of cattle, and here and there showing some cultivation rendered possible by artificial irrigation; the Kirghiz understand perfectly the methods of damming and irrigating. Towards evening we reached the village Urdshar inhabited by Cossacks and Tartars, and continued our journey on the 20th, accompanied by a picket of twelve Cossacks from Bagti, who for ten days had been awaiting our arrival. The steppe was here by no means monotonous, it was even rendered picturesque by the view of snowy mountains around. Perhaps larks, in six or seven varieties, are the commonest birds here, besides these the black-headed wag-tail, the red-throated tit-lark, steppe-fowl, bustards, and cranes: of these mostly *grus virgo*. Wild geese (*Anser cinereus*) animate the steppe in great numbers, wherever there is stagnant water. We find our house-sparrow near the solitary yurt camp, and the swallow (*Hirundo rustica*) tries continually to build her nest on the top ring of the yurt. Where the grass is higher the quail is to be seen, and our cuckoo belongs to those birds which first greet the early morn. Everywhere we found the *Charadrius gregarius* single; the females already bringing out their young ones, are so tame that they allow you to approach within ten steps. Here we saw for the first time the saiga antelopes; they were unfortunately too shy and kept out of range. Late at night we arrived in Bagti, a clean but small military village, with barracks and soldier's houses; on May 21 we entered the Celestial empire, and advanced towards Tschugutschak, only twenty-one versts from Bagti. We passed over a hillock and the town was lying before us; we saw the brown clay walls of low, flat houses, little differing in colour from the steppe. We passed through the narrow streets, and the many-cornered bazaar (partially roofed) to the houses of the Governor-general (Dschansun) Djun, the great Barrack; all along our road we were followed by the astonished-looking faces of strange, queer figures. At the gate we had to get off our horses and, according to Chinese custom, ask permission to enter; we were then received at the hall-door by an elderly gentleman of about fifty, and introduced to his general. It was very hard to keep up a conversation, as every word had to be translated from Chinese into Kirghisian, Russian, and German, and *vice versâ;* on the whole the old gentleman treated us with the well-known speeches of Chinese politeness, placing everything at our disposal, &c. We went to see the bazaar, which contained little really Chinese ware, and so we bought nothing worth mentioning; from there we went into the quarter of the Tartars and had a very good dinner with a rich Tartar, whose very pretty wife, picturesquely dressed, presided. Tamar Bey, our Kirghisian friend, a Mahometan, had to remain outside. The governor kindly offered to provide night-quarters but we declined, and proceeded on our journey before evening; we were told that the nearest yurts were only eighteen versts distant, and so I too determined to ride in spite of my great fatigue. Unfortunately the yurts were thirty versts distant instead of eighteen, moreover the Cossack who accompanied me lost his way and so we arrived after having done thirty-five versts.

"We rested now for thirty-six hours and then went on with telegas, but could not get on very quickly on account of the intense heat (100° F. at noon in the sun and 108° F. in the yurt).

"The road to Saissan led over a steppe more than 3000 feet high, bordered on both sides by mountain ranges. We were still on Chinese territory, yet near small, rapid mountain streams, we passed here and there yurt camps of the Kirghiz and Kalmucks, Russian subjects who pasture their herds quietly on Chinese ground and grow oats and rye by help of Chinese irrigation; they are unmolested by the owners of the land or the 'Tungans,' who are mortally afraid of everything called Russian. Late in the evening of May 24 we reached a plateau high up in the mountains, and rested the whole of the 25th, enjoying the cool refreshing mountain air. The place is called Bugutusai, and is a frontier picket. During summer there are twenty-five Cossacks stationed here who have to chastise immediately any inroads of the 'Tungans.' There is always a post on a pretty high mountain, whence there is a good view far into China, as far as the snow-covered heights of the Urkandscha mountains. Not far from there are great heaps of stones, the remains of Chinese frontier posts, the garrisons of which were killed this spring by the Tungans. Near our place was a small river in which were crab-like animals. Towards evening came Dr. Pander from Saissan; he is the son of the famous anatomist who, together with d'Alton, published valuable atlases; besides refreshments he brought letters, the first which we obtained since leaving St. Petersburg. We started again early on the morning of the 26th, and descended into a plateau bordered for about fifty versts by the northernmost range of the Tarbagatai. The steppe consisted nearly throughout of gravel and stony soil hardly covered with plants; it was the most monotonous steppe we had seen so far with the exception of the pure salt steppe. The mountains by which it was surrounded gave it the appearance of a pleasant picture, but the heights danced in the heated air in a most fantastic way. After having crossed the plateau we found Aarantassas awaiting us; they brought us towards evening into Saissan, where we were most hospitably received in the house of Major Techanoff, the chief of the district who had accompanied us hither from Lepsa. The road was very good, but leads uninterruptedly through bare ravines in the fantastically weathered slate and green but treeless cones of mountains down into the steppe of the black Irtish, bordered at the horizon by the dim snowy heights of the Altai. As soon as we reached the plain we found ourselves on the regular post-line with its verst poles. Saissan is only a military post and consists of small neat-looking houses, broad streets with canals and planted with willows. It is an important place for the trade with China, and will be more important after being made a city. Even now large camel caravans pass through Saissan providing the Chinese army with flour; therefore there is more life here than is elsewhere to be found in this region."

THE "CHALLENGER" EXPEDITION

WE publish with pleasure the following additional testimony to the value of the *Challenger* Expedition:—

To the Editor of "Nature."

20, Palmerston Place, Edinburgh, October 2, 1876.

DEAR SIR,—Perhaps you will kindly allow me through your pages to make known to my colleagues of the *Challenger* Expedition the accompanying gratifying resolution passed at the late meeting of the Naturalists and Physicians of Germany.

Believe me, yours very faithfully,

C. WYVILLE THOMSON.

To Sir Wyville Thomson, Professor of Zoology at the University, Edinburgh.

Hamburg, September 21, 1876.

THE forty-ninth meeting of German Naturalists and Physicians, the first which has taken place since the return of the expedition of the *Challenger*, has, in its general session of September 20, unanimously resolved to express its recognition and thanks to the promoters and to the members of this expedition, by which the knowledge of the physical and biological conditions of the ocean has been so greatly extended.

We have the honour to communicate to you this resolution by forwarding the accompanying extract from the Protocol, and pray you to make it known to all concerned.

The Presidents of the Forty-ninth Meeting of German Naturalists and Physicians,

SENATOR KIRCHENPAUER,
DR. DANZEL.